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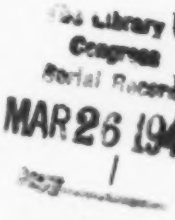

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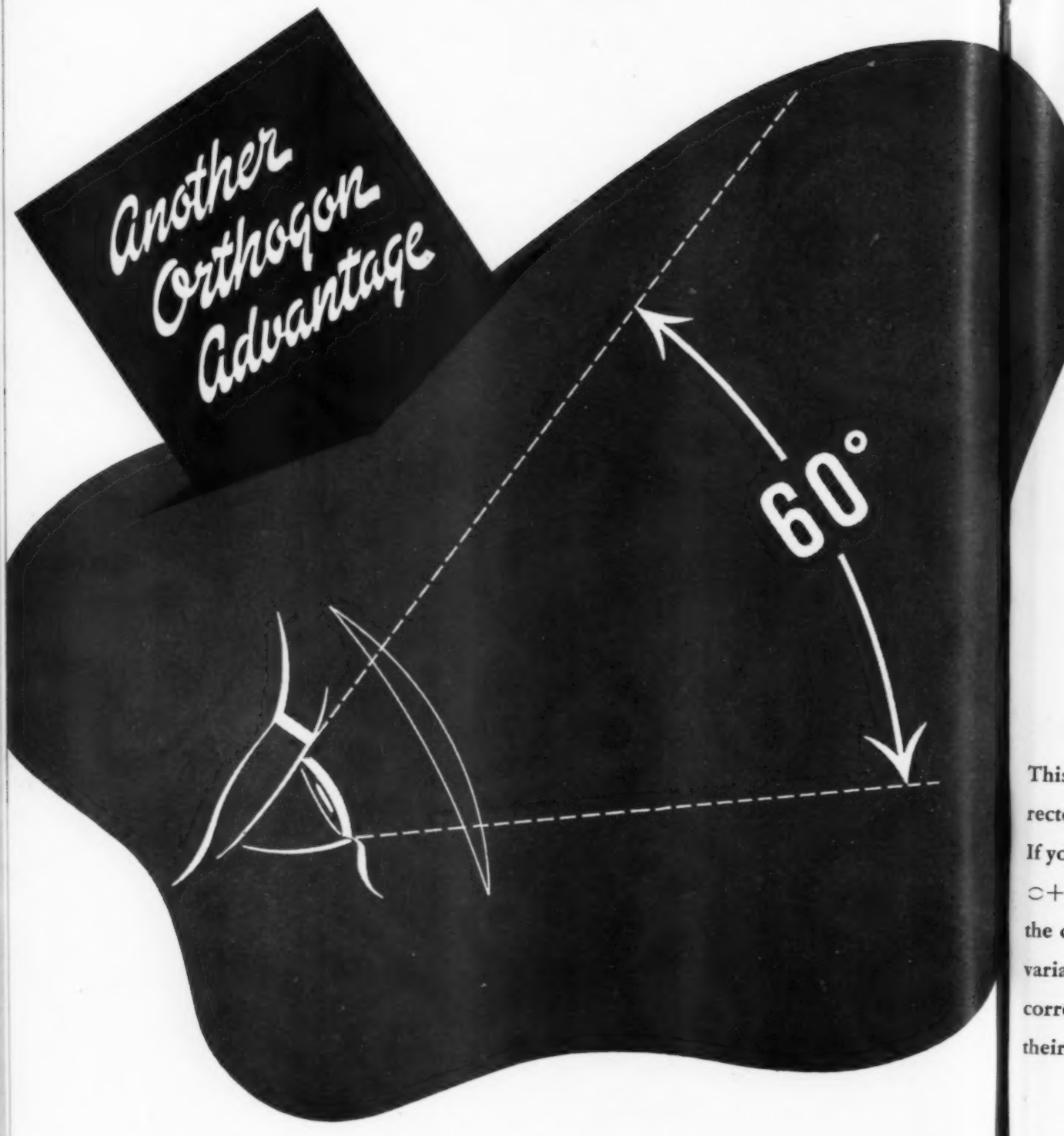
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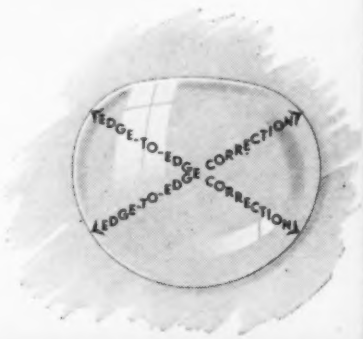

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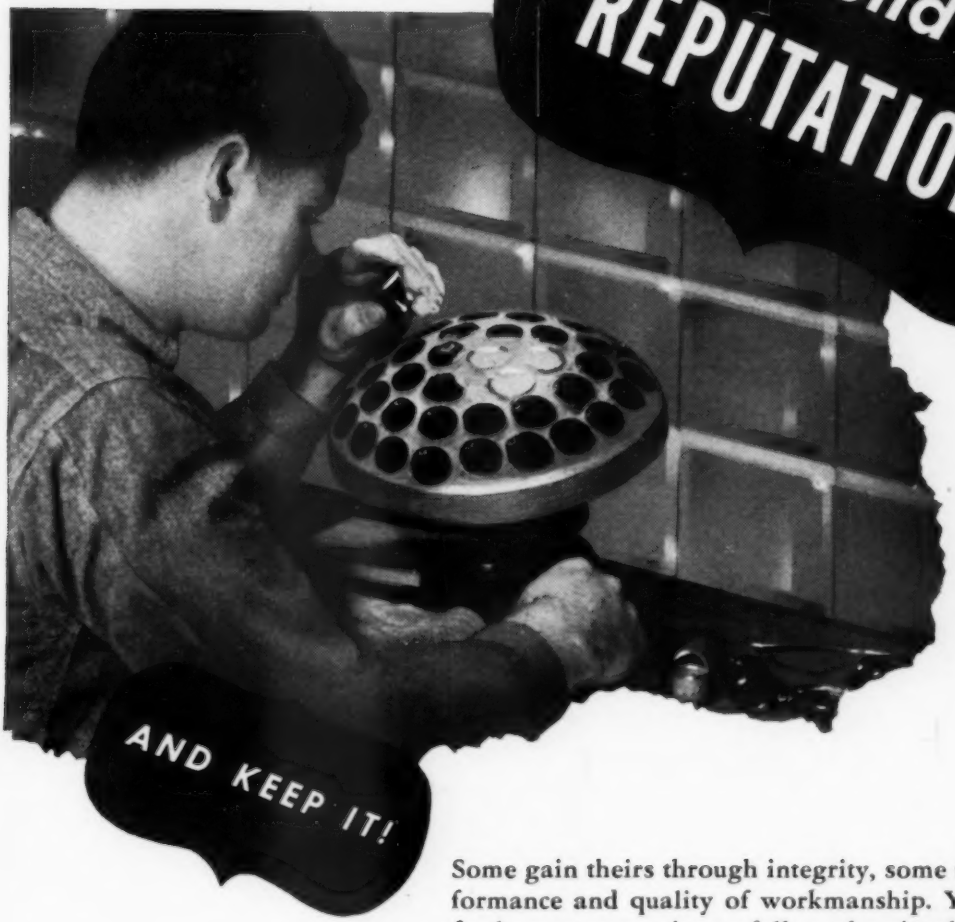

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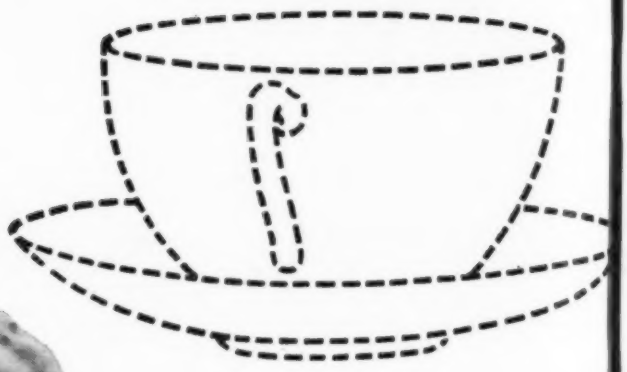

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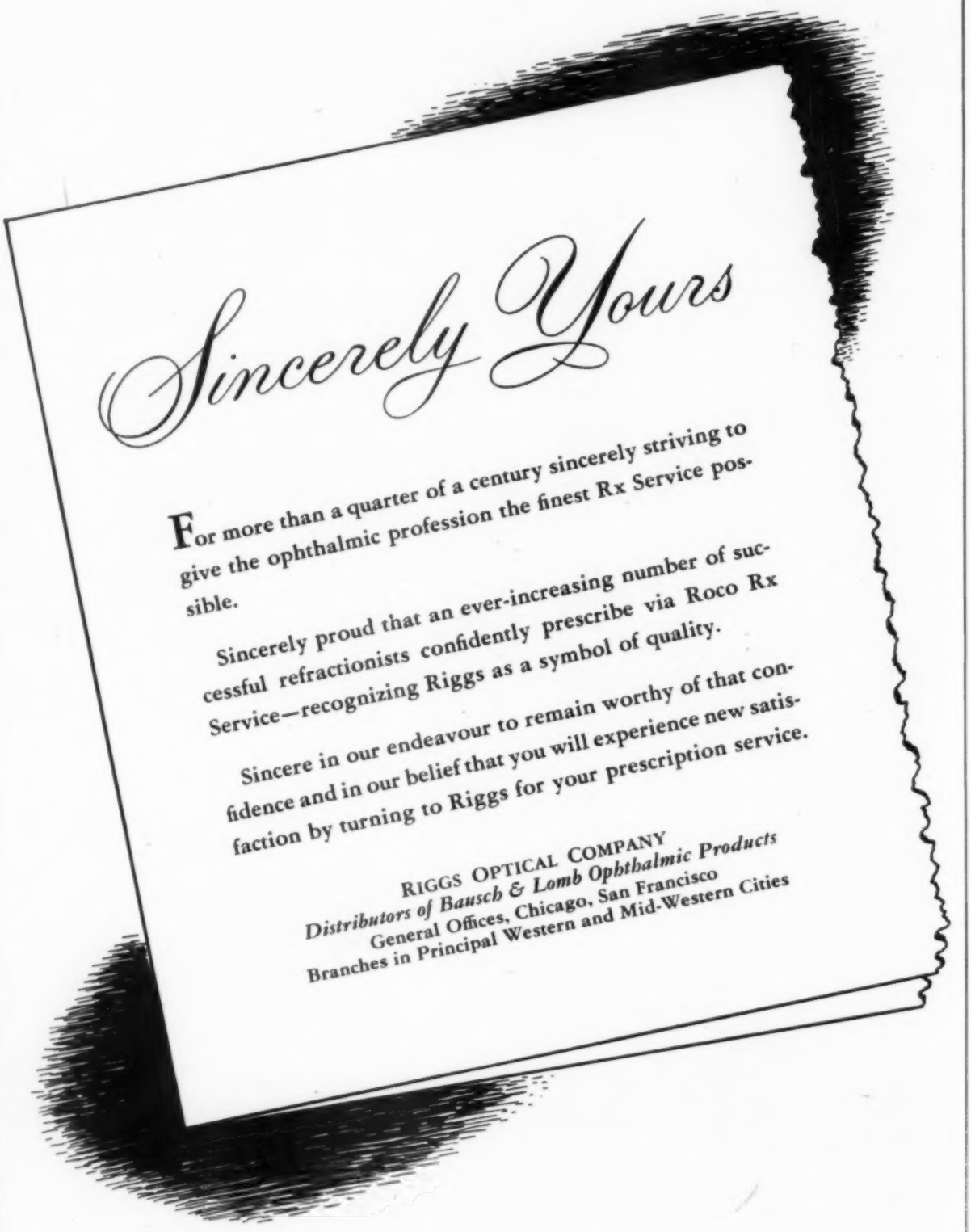
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Vol. 22 MARCH, 1945 No. 3

ON ASTIGMATISM*

Robert E. Bannon and Rita Walsh
Dartmouth Eye Institute, Hanover, N. H.

PART I*—HISTORICAL SURVEY

Early Investigations
Corneal Measurements
Subjective Methods
Development of Retinoscopy

EARLY INVESTIGATIONS

The term "astigmatism" was suggested to Sir George Airy about 1845 by the Rev. Dr. William Whewell,[1,2] professor at Cambridge, philosopher and historian of science. Prior to that time the condition was known as "irregular refraction" and is said to have been first mentioned by Isaac Newton[3] in 1727. It has been claimed that the word *astigmatism* is inaccurate etymologically; that *astigmism* or *astigmia* would be a better term. Dixon[4,5] called attention to this in 1870. He says:

> "Astigmism would be the more correct term, στιδμή [stigme] being commonly used by Greek writers to express a geometric point, while στίδμα [stigma] always signifies something material, more or less visible and tangible—a puncture, mark or spot. I took the liberty of pointing this out to the late eminent scholar, Dr. Whewell, who had originally suggested the word astigmatism and he approved of astigmism as being etymologically the better formed word."

We have verified Dixon's conclusion that "astigmism"† would be the better term. From a practical point of view, however, there is no sense in attempting to bring about a change at this late date. The

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*This is the first of a series of four articles dealing with various clinical aspects of astigmatism. Presented before the Twenty-first Annual Meeting of the American Academy of Optometry at Chicago, Illinois, on December 10, 1944. For publication in the March, 1945, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Dr. Royal C. Nemiah, professor of Greek at Dartmouth College, has confirmed the above statement and has agreed that there is nothing to be gained by attempting to change the term now.

word "astigmatism" has had such wide and long usage that its meaning is understood and accepted by everyone familiar with optics.

In 1800 Thomas Young[6] had described an astigmatic condition in his own eye. He wrote:

> "My eye, in a state of relaxation, collects to a focus on the retina, those rays which diverge vertically from an object at ten inches from the cornea, and the rays which diverge horizontally from an object at seven inches distance. For if I hold the plane of the optometer* vertically, the images of the line appear to cross at ten inches; if horizontally, at seven."

Young attributed his astigmatism to an obliquity of the crystalline lens with the visual axis; he demonstrated that it was not due to the front surface of the cornea by immersing his eye in water (thus eliminating the front surface of the cornea as a refracting surface), adding convex lenses to restore clear vision, and remeasuring with the optometer the same amount of astigmatism.

The Royal Astronomer, Sir George Airy,[7] discovered astigmatism in his left eye about 1825 by observing the image of a light which appeared circular to one eye but elliptical to the other. He determined the amount of astigmatism by measuring the distance at which the light appeared as a streak in one meridian and then the distance at which the light appeared as a streak in the meridian at right angles to the former. This is the basis of the subjective method of stigmatoscopy[8,9] for the determination of astigmatism. Airy calculated the necessary focal powers and had a sphero-cylindrical lens ground which improved his vision considerably. This was the first time a cylindrical lens was used to correct astigmatism.

At about the same time (1825) a clergyman[10] in this country observed a similar defect in both his eyes. Lenses for the correction of his astigmatism were made at the time by McAllisters, opticians in Philadelphia, who were the first to grind cylindrical lenses in this country. Goode[11] in 1846 reports astigmatic measurements on his own eyes by Airy's method. He also was the first to give several case histories of persons he examined for astigmatism and for whom he calculated the corrective glasses.

---

* An optometer is an instrument to measure the refractive and accommodative powers of an eye by sliding a test object along the optic axis of a lens of constant power until the image is at the far point of the eye and is seen with maximum clearness by the unaccommodated eye.

In 1838 Sturm[12] presented the theory of image formation for a narrow bundle of astigmatic rays passing through a very small aperture. He discovered that all image rays go through two mutually perpendicular focal lines separated by a focal interval (Sturm's Conoid). He believed his theory was applicable to the eye, where there is a series of media of different refracting power separated by surfaces which are not strictly spherical nor symmetrical about a common axis. Gullstrand[13] later refuted this on the basis that the aperture in the eye is very wide. He said: "In the case of the eye . . . the notion of these focal lines is fundamentally false." Nevertheless, Sturm's theory of image formation applies to trial case lenses, which are the means used to correct that part of human astigmatism which is correctible. Therefore, Sturm's explanation is very helpful* in aiding one to understand what takes place in the correction of astigmatism with cylindrical lenses.

CORNEAL MEASUREMENTS

Objective measurements of the cornea have been made since the 17th century. The Jesuit, Christoph Scheiner[14] (1575-1650) describes his experiments as follows:

> "Take a number of glass spheres of various diameters. Sit some person opposite a window, so that the image thereof is mirrored in his cornea. At the temporal angle of the eye hold the spheres, one after another, until a sphere is found which reflects an image of the window of exactly the same size as that reflected by the cornea. The cornea is a section of a sphere of just that curvature. You can easily determine in this way, whether or not the two corneae are of equal curvature."

About a century later, du Petit[15] (1664-1741) made a number of scientific measurements of the constants of the eye. Among them he determined the curvature of the corneae of enucleated eyes; he cut out segments of circles of different radii in copper plates and applied them to the corneae. The segment which fitted the cornea most exactly had the same radius [as the cornea]. In this way Petit was the first to show that the cornea flattens out toward the periphery. About the end of the 18th century (1795) Home[16] and Ramsden tried to study the reflected images of the cornea to find if there was a change of curvature of the cornea during accommodation. However, it remained for Gerson[17] (1810) to be the first to point out the existence of corneal astigmatism. Later Kohlrausch[18] (1839) measured the radius of the cornea, utilizing reflected images but it was Senff[19] in 1846 who showed that the cornea

*For example, see "The Significance of Sturm's Interval in Refraction." by Avery DeH. Prangen. Am. J. Ophth.: (April), 1941: 24 (4): 413-422.

was ellipsoidal rather than spherical. Nevertheless, it was not until 1854 when Helmholtz[20] applied the principle of doublement* to the measurement of the corneal curvature by reflected images that the first successful keratometer was devised. Helmholtz's instrument was for the purpose of measuring the astigmatism of the anterior surface of the cornea and also, through a more complicated process, the two surfaces of the crystalline lens. Donders[21] described the use of Helmholtz's ophthalmometer and made a considerable number of measurements with it. In respect to this Donders said (p. 461):

> "I have not endeavoured in these cases to compare the astigmatism . . . proceeding from the cornea with the total astigmatism. . . . No useful result was to be expected from doing so."

Javal's collaboration with Schiotz[22] in 1881 resulted in an improved ophthalmometer and notes on its clinical application. About 1880, Placido,[23] a Portuguese ophthalmologist, invented the keratoscope, later known as Placido's Disc, and Javal[24] in 1883 advocated the use of a similar disc to study the reflections from the cornea when the eyes were rotated in various directions. Javal maintained this would supplement the information furnished by the ophthalmometer since the latter could only determine the curvatures of a very limited area of the cornea.

SUBJECTIVE METHODS

A device for the subjective measurement of astigmatism was described in 1849 by Sir George G. Stokes.[25] Two cylinders of equal, but opposite power, were placed in contact and rotated with respect to each other, thus varying the power of the resultant cylinder until it suited the eye. The value of the equivalent cylinder was then calculated or read off a scale. The greatest disadvantage of Stokes' cylinder is the fact that the spherical component varies in amount as the two cylinders are rotated. This, of course, would interfere with the fog in the subjective determination of astigmatism.

Donders is credited with the introduction of cylindrical lenses into the trial case, although Javal also advocated the use of cylindrical lenses for the subjective determination of astigmatism. Donders[21] (p. 514) was also the first to mention the role of astigmatism in cases of asthenopia. He recognized that "a certain degree of astigmatism occurs in all eyes." Besides referring to the methods of Young and Airy, Donders described the use of the stenopaic slit for measuring the error of refrac-

*The method of doublement permits the measurement of distance or separations of constantly moving bodies. This principle had been used successfully for some time in an astronomical instrument, the heliometer.

tion in the various meridians by the use of spherical lenses. However, he advocated the use of cylindrical trial lenses as being more satisfactory than the stenopaic method. Donders[21] (p. 489) discussed the value of the ophthalmoscope in detecting astigmia by virtue of the elliptical appearance of the optic disc (Knapp,[21] 1861) and the fact that the fundus of an astigmatic eye is not equally clear in all meridians. As every writer on astigmatism has attested, the inclusion of tests for astigmatism as part of the refractive examination was due largely to the excellent writings of Donders.

Charts for the subjective determination of astigmatism were introduced by Javal. In 1865[26] he described the use of an astigmatic dial with radiating lines at 15 degree intervals. Three years later John Green[27] presented before the American Ophthalmological Society, his series of astigmatic charts which he had previously described in Utrecht in 1866:

(1) The familiar clock dial still in use today having three parallel radiating spokes at 30 degree intervals.

(2) A series of seven sets of five parallel lines arranged in groups inclined at different angles in 30 degree steps, i.e., one group of five parallel lines: axes 90, 120, 150, 180, 30 and 60.

(3) Several other charts with radiating lines and dots of various thicknesses and sizes with various separations from 5 degrees to 30 degrees.

(4) Some of Green's charts had white lines on a black background while others had black lines on a white background; one of his charts had red lines against a blue background and another had blue lines on a red background.

Green should therefore be credited as the first American to develop and make popular astigmatic charts.

Another outstanding contribution of an American: Edward Jackson, in the field of subjective tests for astigmatism is the cross cylinder test on letters. In 1887[28] he presented the cross cylinder test for amount of astigmatic correction; in 1907[29] he explained the cross cylinder test for determining the axis of the correcting cylinder. Since that time the cross cylinder test has steadily gained in popularity and at present it is one of the most commonly used tests for astigmatism.

DEVELOPMENT OF RETINOSCOPY

Sir William Bowman[30] in 1859 noted some reflex movements in the pupil while using the mirror ophthalmoscope. He commented to

Donders[31] (p. 490) that astigmatic errors could be determined in this way. Donders tells of this as follows:

> "My friend Bowman recently informs me that he has been sometimes led to the discovery of regular astigmatism of the cornea, and the direction of the chief meridians, by using the mirror of the ophthalmoscope much in the same way as for slight degrees of conical cornea. The observation is more easy if the optic disc is in the line of sight and the pupil large. The mirror is to be held at 2 feet distance, and its inclination rapidly varied, so as to throw the light on the eye at small angles to the perpendicular and from opposite sides in succession, in successive meridians. The area of the pupil then exhibits a somewhat linear shadow in some meridians rather than in others."

A French physician, Cuignet[31], explained in 1873 the use of the instrument with a plane mirror to detect and even measure not only astigmatism, but the other errors of refraction. He called the process keratoscopy and initiated its clinical use. Another Frenchman, Parent[32] in 1880 demonstrated the optical basis of retinoscopy and proposed this name. The theoretical basis of the phenomena observed in retinoscopy was investigated and described by Landolt[33] (1878) and Leroy[34] (1887). Chibret[35] (1882) advocated the plane mirror in determining the presence and degree of myopia by the shadow test. Priestly Smith[36] in 1884 described the instrument and its use.

Edward Jackson[37], of Philadelphia and Denver, complained in 1885 about the lack of enthusiasm in America for this test. He devoted much of his time to studying the theoretical basis and practical applications of skiascopy and, using his own words, "to bring about the more general adoption of skiascopy as an essential part of the examination for ametropia." In this endeavor he wrote more than a dozen articles as well as one book[38] on the subject.

Another American, Swan Burnett[39], studied astigmatism enthusiastically and described the role of retinoscopy and ophthalmometry in its diagnosis. His work resulted in numerous papers and a comprehensive book, "A Treatise on Astigmatism," published in 1887, which were influential in having the examination for astigmatism included as part of a routine refraction. He and Weir Mitchell[40] were among the first in this country to realize and emphasize that asthenopia was a more frequent complaint of astigmats than poor vision.

The method used in retinoscopy has been essentially the same since its introduction: light is reflected into the eye by a plane or concave mir-

ror and the movement of the illuminated area is observed as the mirror is tilted. About the only outstanding improvement has been the introduction of the transparent mirror by Gullstrand[41] in 1911.

Dynamic retinoscopy was introduced by Andrew J. Cross[42] in 1902 as a method of determining the refractive status of the eyes when accommodation and/or convergence are being used. Pascal[43], Tait[44], Sheard[45], and others have developed further the theory and use of dynamic retinoscopy. Differences in the amount or the axis of the astigmatism when the eyes are used in distance or near vision may be determined by comparison of the static with the dynamic retinoscopic findings. However, such differences should be interpreted rationally and should be modified by the inherent limitations peculiar to the methods used. Some of these limitations will be discussed in Part II of this paper.

Since the end of the last century, retinoscopy and ophthalmometry have been considered as the two best *objective* means of measuring astigmia. Fortunately, refractionists do not have to rely solely on these objective means but are able to refine the ultimate correction for astigmia by various subjective tests. Before discussing further the subjective techniques, a few of the significant limitations in the objective tests for astigmatism will be presented.

APPENDIX

CHRONOLOGICAL OUTLINE

EARLY INVESTIGATIONS

1845	Whewell	term "astigmatism"
1881	Dixon	terms astigmia and astigmism
1800	Thomas Young	discovery of astigmatism
1825	George Airy	introduction of cylindrical lenses
1846	Goode	case histories on astigmatism
1838	Sturm	theory of astigmatic imagery

CORNEAL MEASUREMENTS

1600	Scheiner	by set of marbles
1723	du Petit	cornea flattens toward periphery
1795	Home and Ramsden	reflected images
1810	Gerson	corneal astigmatism
1839	Kohlrausch	attempt to measure corneal radius by reflected images
1846	Senff	cornea ellipsoidal
1854	Helmholtz	ophthalmometer
1881	Javal and Schitz	clinical ophthalmometer
1880	Placido	keratoscopic disc

SUBJECTIVE METHODS

1849	Stokes	rotary cylinders
1864	Donders	clinical importance of astigmatism
1865	Javal	astigmatic dial
1868	John Green	astigmatic dials

1876	Weir Mitchell	headaches and eyestrain
1887	Edward Jackson	cross-cylinder tests on letters
		RETINOSCOPY
1859	William Bowman	introduced retinoscopy
1873	Cuignet	all ametropias: plane mirror
1880	Parent	optical basis of retinoscopy
1878	Landolt	theoretical basis of retinoscopy
1887	Leroy	theoretical basis of retinoscopy
1882	Chibret	plane mirror
1884	Priestly Smith	described instrument
1885	Edward Jackson	sponsors retinoscopy in United States
1887	Burnett	sponsors retinoscopy in United States
1911	Gullstrand	transparent mirror
1902	A. J. Cross	dynamic retinoscopy

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DISCUSSION

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Since Part I "Early Investigations" sets forth historical facts bearing on the discovery of astigmatism, its nomenclature, the introduction of cylindrical lenses, case histories and theory of astigmatic imagery—all of which consists essentially of factual data—the treatment of this section therefore invites very little controversial discussion.

A comprehensive study of the subject of astigmatism in all of its aspects would be incomplete without such historical data as has been presented. As a fundamental premise upon which to erect material of a more clinical and practical nature which is to follow, one value of this historical survey is the high-lighted pattern which is presented of evolutionary developments in the recognition of astigmia, the early methods of measuring the anomaly and its correction compared with the more advanced methods of today. It shows that evolutionary trial and error process which has step by step brought the science of measuring and correcting astigmatism to a highly practical stage of development.

Corneal Measurements. In connection with this phase of the subject, it will be fitting to include the following additional data: Referring to Helmholtz' instrument (1854) for measuring corneal curvature, it was admitted by Tscherning that this originally constructed instrument which was also used by Young was not practical and results were unreliable. It was about 6° from patient to instrument and no means of finding meridians.

Laurent provided suitable mounting permitting flexibility of adjustment and doubling device.

In connection with this "Historical Survey" it will be of interest to note that the first case of astigmatism in America was reported by Isaac Hays, who was surgeon to the Wills Eye Hospital in 1834. This was the fifth case of astigmatism reported in the entire world.

Subjective Methods. Certain limitations in the relationship between the ophthalmometric and subjective astigmatic findings should be stressed and it should be noted from a historical point of view that progress in the application of known principles of astigmatic correction were retarded for failure to recognize at an early date these conditions as are

herewith briefly set forth. A more elaborate treatment of these factors properly belongs to other phases of this subject.

One finding as of the ophthalmometer has no fixed relationship or comparison with the subjective. The ophthalmometric finding is of one part while the subjective is the sum of all of the parts. One component is never equal or greater than the whole.

The components include the following on the basis of possible differences in the various indices: Anterior and posterior surfaces respectively of the cornea, corneal index, difference in index in cornea and aqueous, anterior capsule, anterior surface of lens, anterior and posterior surfaces of cortex, posterior surface of nucleus, scattering due to non-homogeneity of vitreous, retinal astigmia, cerebral interpretation, posterior surface of capsule and alteration of these previous six surfaces during accommodation.

Retinoscopy. In connection with the splendid treatment of the historical survey of Retinoscopy by the authors, it may be of interest at least for the records to include the following: While Cuignet, the French physician, as has been stated in the paper by Bannon and Walsh, published in 1873 the possibilities of keratoscopy as a practical method of measuring refractive errors, it was his student Mengin in 1878 who introduced the practice in a Paris clinic which was elaborated on and popularized by other converts of this technique.

Then in London in 1880, Lylton Forbes published an account of the light and shadow movements in the pupil. In 1881, A. Stanford Morton published a full description of the test in his work refraction of the eye. In 1882, Charnley gave the fullest demonstration of its optical basis.

In conclusion, it is no doubt apparent to this assembly that this Historical Survey by Bannon and Walsh offers not only valuable data for the Archives of the Academy but it establishes those fundamental facts of origin and evolutionary processes of development which are so essential to the fuller appreciation of their treatment of the more practical phases of the subject of astigmatism which is to follow.

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DEVELOPMENT OF REFRACTIVE AND OPTICAL WORK IN THE ROYAL CANADIAN AIR FORCE*

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The practice of optometry is new compared with that of other recognized healing arts. In Canada there was no legally recognized optometry during the last world war. The first optometry Act of Ontario was passed in 1919, only twenty-five years ago. The first technical course, which was held at the Toronto Technical School, began in December, 1919, and was taught by J. C. Thompson, the present Dean of the College of Optometry. The teaching of optometry was continued at the Toronto Technical School until the College of Optometry was opened in 1924. At that time the entrance requirements were junior matriculation, and the course covered but one year, with one thousand hours of instruction. From that small beginning a course has developed at the College of Optometry which requires Senior matriculation with three years at the College of Optometry.

The opening of World War II in 1939, found ophthalmic flying standards almost the same as those at the close of 1918. Many problems required immediate attention, aircrew selection being one of the most urgent. As the Royal Canadian Air Force was a very new fighting service, the practices of the Royal Air Force were followed to a large extent in the matter of visual standards and the use of refractive corrections. Previously laid down standards related to vision were used. Experienced practitioners in internal medicine, ophthalmology, otolaryngology and neuropsychiatry began to assemble information from studies relating their specialties to flying performance. Out of the ophthalmic data has developed a new conception of the ocular requirements. In general, it may be said that these studies have tended very definitely to indicate the importance of visual acuity and color vision and to attach much less importance to ocular muscle balance tests.

Early in the war, the Projecto-Chart was adopted as a standard means of measuring visual acuity. Thus, uniformity of testing was obtained where this was impossible with the old Snellen's Charts, the illumination and cleanliness of which was difficult to control. The Mad-

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dox Rod and a carefully conducted cover test were made standard procedures.

With the entry of Japan into the war the supply of Ishihara colour charts was cut off. The book of charts published by the American Optical Company was studied as a replacement. This book of charts is composed of a selection of Stilling and Ishihara type charts. The charts in the selection are not all of uniform performance. Over 600 random tests were carried out, as a result of which a series of charts with the best performance characteristics was selected. This adapted test is now in general use in the R. C. A. F. under the name of the color plate test. Those who failed the test were first given a supplementary test with the Eldridge Green or the Giles Archer lantern. In the manner used, these lanterns gave very equivocal and unsatisfactory results. The R. C. A. F. adaptation of the R. C. N. color lantern was developed as a substitute. A distinct improvement in the situation resulted. However, there is much to be done in the development of a rapid, accurate color vision lantern test which will select candidates at safe levels. This work is proceeding.

Special reference should be made to a study of the role of aniseikonia in flying performance. A further study dealing with the role of orthoptics in aviation is far from complete, but it appears that in a small number of selected cases, orthoptic training is of value. Also orthoptic procedures have been found to be of considerable diagnostic importance.

Out of the welter of activities, duties and interests of the ophthalmologist a quite definite administrative pattern developed. Early in the spring of 1943, the medical branch under Air Commodore Tice, was re-organized into two branches under two deputy directors, one professional and one administrative. Under the deputy director in charge of professional duties were set up consultant positions for the various elements or specialties in medicine. In this picture, a consultant for ophthalmology was placed. It is his duty to administer the multifarious duties and interests outlined above and to correlate them with those of the rest of medicine. A similar group of specialist medical officers, with similar duties, in a somewhat subsidiary capacity, has been set up in each command. This group is called the Command Medical Board. At each of these Boards there is an ophthalmologist. Working under his supervision and for his assistance there is a female orthoptist. The orthoptist assists with ocular muscle balance studies, diagnostic procedures, and carries out orthoptic treatment on those cases selected by the ophthalmologist. The orthoptist also takes fields of vision and assists with the

history-taking, filing and other procedures. A number of ophthalmologists at the Command Medical Boards and other centres, have become overburdened with refractions. Optometrists have been supplied and are proving most satisfactory. They are also assisting with history taking, perimetry and muscle studies.

Now, let us turn to the mechanical side of ophthalmology and optometry. Considerable difficulty was experienced with the type of frames issued early in the war, and it was necessary therefore to adopt a new spectacle frame suitable for service conditions. Some of the requirements for this frame were: rigidity, adjustability, a large or oversize shell pad, and an eyewire made D shape to eliminate danger of lenses turning in the frame. It also was necessary to use a thin, flat side temple with a close fitting end-piece which would fit under the respirator. Such a frame was adopted. This frame is proving satisfactory in all respects except appearance, which would necessitate a rimless mounting. This is unsatisfactory from the service standpoint. A complete stock of frames in the required sizes of fronts and temples will shortly be available, thereby eliminating certain difficulties which developed during the transition period.

As the visual standards for pilots and navigators were lowered it was necessary to fit glasses to improve the visual acuity to the required standard. This problem is now being handled very satisfactorily by fitting surface hardened lenses to service frames. Surface hardened lenses are also being supplied to certain trades in ground crew.

As the number of refractions and spectacle fittings increased it became evident that many glasses, which had been supplied to service personnel were not being worn. A survey of the spectacle situation was necessary to determine the causes and remedy. The responsibility for this survey was assumed by Wing Commander John V. V. Nicholls when he was placed in the position of consultant in Ophthalmology June, 1943. Unavoidable delays occurred, and it was not till December, 1943, that the survey was begun.

The chief purpose of the survey was to check:

(a) The accuracy and the quality of material with which the prescription had been filled by the civilian contractor.

(b) The accuracy of the fit and adjustment of the frames. Service frames were checked and wherever possible personal glasses which had been supplied on a service prescription.

(c) Reasons for not wearing service glasses.

The survey was carried out with the following equipment used for checking:

(i) Lensometer Jr.
(ii) Lens Gauge
(iii) Thickness Caliper
(iv) Protractor
(v) Fitting pliers, screwdriver and rule
(vi) Surface hardened lens tester

R. C. A. F. and R. A. F. stations in Newfoundland and across Canada were visited. All of the larger, and most of the smaller contractors, were checked on at least one, and on some occasions, more than one station. The procedure when visiting a station was as follows: A sufficient number of service personnel who had been issued glasses, preferably during the previous two or three months were instructed to report to the hospital. No selection was used, they were chosen at random. The prescription for glasses was referred to and the glasses checked against it as previously mentioned. Results of the examination of each pair of glasses were recorded.

The results of this survey were most disappointing to those in the R. C. A. F. who had more or less assumed that glasses would be supplied as ordered. Many lenses were found to be off axis. A large number of lenses "off center" and with other defects indicated that they had been other than first quality in the uncut form. Spectacles from some contractors were found to be very badly fitted. There were also cases of aircrew in training where the men were found attempting to wear surface hardened spectacles the frames of which gave evidence of having had no frame fitting.

Immediate action was taken by the Director of Medical Services to set up a standard of requirements in lenses. Thus, detailed specifications were elaborated and later were accepted with minor changes by the R. C. N. and the Army, so that now there are uniform specifications for the three services. Inspectors were appointed by the Director of Aeronautical Inspection and instructed that these requirements must be carried out.

The following are the standards of lens requirements and tolerances:

GENERAL DESCRIPTION

(a) All lenses shall be of the meniscus type, made of the best quality optical glass, ground and polished to the accuracy and refinement of first quality corrected

lenses (Bausch and Lomb "Orthogon," Consolidated Optical Company "Tillyer," or Imperial Optical Co. "Corectal," s.andards, and trade marked).

(b) *Lens Finishing*—All lenses must be accurately ground and finished to size so that there shall be no jamming or wobbling in the lens wire.

(c) TOLERANCES PERMISSIBLE IN THE FILLING OF PRESCRIPTION FOR REFRACTIVE CORRECTIONS ARE AS FOLLOWS:

(i) *Sheres*—0 to plus or minus 20.00—strength of lens supplied must be within plus or minus 0.12 of that prescribed.

(ii) *Cylinders*—0 to plus or minus 10.00—strength of lens supplied must be within plus or minus 0.12 of that prescribed.

(iii) *Axis of Cylinder*—0 to plus or minus 0.50 cylinders. Axis must not be more than 4° off that prescribed.

Plus or minus 0.62 to plus or minus 1.50 cylinders. Axis must not be more than 3° off that prescribed.

Plus or minus 1.62 to plus or minus 10.00 cylinders. Axis must not be more than 2° off that prescribed.

(iv) *Centering*—Must be accurate for the purpose for which the glasses are intended (distance or reading). A vertical deviation greater than 1 mm. and a horizontal deviation greater than 2 mm. off such a centre are not permissible. The optical center of each lens on delivery is to be marked with a spot of ink.

TESTING

(a) The accuracy of the fulfillment of the prescription shall be tested by the Department with a lensometer. Faulty fulfillment of the prescription may be considered cause for immediate cancellation of the contract.

(b) The Contractor shall supply free of charge all lenses expended in the tests.

FITTINGS

Lenses supplied are to be fitted to Service Spectacle Frames supplied by the Unit Medical Officer, except where specifically stated in contract when fitting will be carried out by R.C.A.F. Optometrists or fitters.

In addition to the above, Surface Hardened Lenses supplied to aircrew are to conform to the following:

Axis of Cylinder—0 to plus or minus 0.50 cylinders. Axis must not be more than 3° off that prescribed.

Plus or minus 0.62 to plus or minus 1.50 cylinders. Axis must not be more than 2° off that prescribed.

Plus or minus 1.62 to plus or minus 10.00 cylinders. Axis must not be more than 1° off that prescribed.

The test for adequate hardening shall be that the Lens so treated will resist breakage when struck by a steel ball 5/8 ins. in diameter falling vertically upon the center of the Lens from a height of 1 meter. For the purpose of this test the Lens shall be supported at its edge all round and for 5 mm. in from the edge all round.

Since experience had proven that standards were of no use without an adequate system of checking, action was taken to acquire a sufficient number of lens gauges and lensometers Jr. to check all spectacles before being accepted by the R. C. A. F. These have now been received and are being distributed across Canada. Instructions to the Inspectors are that only those glasses which come up to specifications may be passed for acceptance.

Optometrists will be interested in learning just how optometrists are fitting into this great organization. It is recognized that some things

have seemed to move very slowly. To the civilian it may have appeared that very little was being done optometrically. But behind all this were those who had a real appreciation of the ability of optometry to serve, and have continued to work to the end that optometry would be given a fair opportunity to prove itself. That time is here.

Several months ago the technical grade for optometrists was established with the rank of sergeant. As in any new venture some one must break the way and there have been difficulties. Rank has come slowly for some, recognition for others: antagonism has been gradually broken until at this time reports are highly complimentary and more ophthalmologists are recognizing the need for optometric assistants.

How does the optometrist fit into the R.C.A.F.? As previously mentioned, the ophthalmologist is responsible for all eye care in his command. Cases of eye disease, eye injury, headache or eyestrain reporting to the Medical Officer are referred to the Ophthalmologist. He in turn classifies them according to their complaint. In many commands the number of refractions have reached the point where the ophthalmologist is unable to handle them along with his other work of treating the injured and diseased eyes. This is where the optometrist comes in. The case is referred to the optometrist as the ophthalmologist's assistant. He takes charge of the eye examination carrying out the refraction with or without cycloplegic as required, the results being reported to the ophthalmologist. In a straight refraction, the routine is for the ophthalmologist to check and initial the results as he alone is responsible if anything should go wrong. As a matter of policy it is laid down that the ophthalmologist shall see the patient if correction fails to bring vision to normal, in muscle anomalies, or in any abnormal condition of the fundus or media. Field studies or other special investigation may be carried out by the optometrist under the direction of the ophthalmologist.

With the new system which is just being introduced the optometrist carries the stock of frames. Following the refraction and writing of the prescription, facial measurements are taken and the required size of frame taken from stock. The prescription, frame, and instructions are now sent to the contractor who completes the glasses. These completed glasses are returned to the optometrist who checks the prescription in the Lensometer, also checking to be certain that the lenses fit properly in the frame. All glasses which do not meet standards as laid down must be returned to the contractor. The patient is now notified to report for fitting of the frames and to have the vision checked with the glasses.

In order that this work will be carried out as required and so that the optometrist may have a proper appreciation of his position in the Service, a special course was put on at the school of Aviation Medicine, Toronto, during the second week of March. The subjects considered were:

1. Refraction with and without cycloplegia,
2. Ophthalmoscopy,
3. Muscles,
4. Taking of the history,
5. Lenses and frame fitting,
6. The optometrist in the R.C.A.F.

Those taking part in the lectures were:

Wing Commander J. V. V. Nicholls, Consultant in Ophthalmology, R.C.A.F.,

Squadron Leader J. Minnes, Ophthalmologist,

Squadron Leader MacDonald, Ophthalmologist,

Flight Lieutenant J. Crawford, Ophthalmologist,

Flight Lieutenant Bright, (Clinical Investigation Unit),

Ivan S. Nott, Optometrist.

The writer was in charge of the course, and instructed in the mechanical aspects of optometry. These optometrists who attended the course are now located in the more important centers across Canada.

You will note that with the outline as described, there is a continuous chain of responsibility within the R.C.A.F. and all operations from the initial interview to the final fitting of the glasses are either carried out by R.C.A.F. personnel or under the supervision of R.C.A.F. personnel. All officers who are responsible for the checking of glasses have been appointed special inspectors in the R.C.A.F. and have authority to inspect material and processes used in the production of glasses at any time. There is also a special supervisory officer at A. F. H. Q., Ottawa, whose duty it is to visit all centers and assist in the proper carrying out of all optical work.

It is to be expected that with the introduction of a system which makes such radical changes in what were considered more or less standard procedures problems will arise, and especially so at this time when the excuse can be advanced with a certain amount of truth that help is scarce and trained workers are not obtainable. The R.C.A.F. has no pur-

pose in making these changes other than to assure an accurate fulfillment of the prescription and fitting of the frames for each pair of eyes which require attention. By contrast with the old methods this may seem extreme, but it was necessary under the circumstances that this be done.

The question of the present specifications has been raised. As previously mentioned these specifications were agreed on and are being used by the Army, Navy, and R.C.A.F. The reader will agree that a person in the armed services should receive just as accurately ground and fitted a pair of glasses as should another who is in civilian life and that a man entrusted with a bomber or fighter should have the best that optical science can provide. I am sure those of you who have members of your families in the services would like to feel that what they get is the best. We are of the same opinion and are endeavoring to see that carried out.

Many optometrists have been asking, what do these optometrists get out of it? Let us look at this from the standpoint of the Service as well as the men. We, each of us, have a job to do. That is our privilege and our obligation, especially in time of war. A very good rule to keep in mind is that before we can receive, we must expect to give. Optometry is a new departure as far as the Service is concerned, and unfortunately the medical profession has had some reason for being suspicious of either the ability or intentions of some optometrists. They have probably met some of the unreliable type—consider again the report on service spectacles. Unfortunately, the honest, ethical, well trained man often has to suffer for the less scrupulous individual.

Optometry now has its opportunity and the reports are most encouraging. Those ophthalmologists who a short time ago were skeptical are now most enthusiastic as you may verify for yourselves. Optometrists work along with trained ophthalmologists. They observe diagnostic procedures using the slit lamp, tangent screen and other modern methods. This amounts to a good graduate course which would be difficult to obtain otherwise. They also see as a going concern the practice of a highly specialized branch of medicine where the finest specialists in the different branches of medicine are available for consultation without cost to the patient. A service which few of us could afford in civilian life. Fortunate indeed, is the optometrist privileged to serve in this situation.

SUMMARY

It has been attempted to present a picture of the development of refractive and optical work in the R.C.A.F. A good foundation has been

laid. It is receiving intelligent and enthusiastic direction so that it will not become static. A broad field lies ahead for the well trained, intelligent, and aggressive optometrist.

NOTE—For material dealing with the ophthalmic pattern in the R.C.A.F. the following paper has been drawn upon: Nicholls J.V.V. Opthalmology in the R.C.A.F. C.M.A.J. *50*, 335, 1944.

THE CORRECTION OF ASTIGMATISM FOR NEAR WORK*

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It is the practice among many refractionists to consider the correction for astigmatism for near work to be essentially the same as the correction for astigmatism at distance. This assumption is ordinarily carried out in a routine eye examination by testing for astigmatism at distance only and incorporating the cylindrical correction into the final prescription whether the prescription is intended for near or distance.

That the cylindrical correction provided by such a prescription may not be adequate when used for near work has been pointed out in recent years by Emsley[1], Neumueller[2], and Pascal[3].

The nature of the problem is readily appreciated when it is considered that practically all of the astigmatism is to be accounted for in the plane of the cornea whereas the spectacle correction is placed in a plane some distance anterior to the cornea. This pertains to the fact that a cylindrical lens placed in the spectacle plane does not have the same astigmatic effect in the plane of the cornea for near objects as for distant objects.

Because the resultant effect is similar to that which would be obtained if an otherwise normal eye were to manifest astigmatic accommodation (cf. Howe)[4] a careful distinction should be made between the two phenomena. The latter anomaly, commonly referred to as astigmatic accommodation, is dependent upon the unequal accommodation of the crystalline lens in the different meridians whereas the presently described phenomenon is entirely a matter of optical effectivity of the cylindrical spectacle lens.

For the purpose of computation it can be assumed that all of the astigmatism of the eye originates in the plane of the cornea. The computations based on this assumption would be valid whether the astigmatism is to be attributed to the unequal curvatures in the principal meridians of the cornea or to the obliquity of the line of sight with respect to the corneal surface. Whatever astigmatism may be attributed

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to the obliquity of the crystalline lens with respect to the line of sight may be considered as originating so near to the plane of the cornea as to present a negligible error if assumed to be in the same plane.

The first step in computing the astigmatism effective during near work is to establish a meridian of reference which, for purposes of analysis, may be either of the principal meridians of the distance astigmatic correction. For example if the distance correction is +1.00 sphere ⊂ +2.00 cyl. axis 70°, either 70° or 160° may be taken as the meridian of reference. If, in this case, 70° is selected as the meridian of reference the problem is that of finding the necessary near correction at 160° when the correction in the 70° meridian (+1.00) remains fixed. If on the other hand 160° is selected as the meridian of reference, and the correction in this meridian (+3.00 D) is fixed, it becomes necessary to find the near correction at 70°. The resultant astigmatism correction indicated in the two instances would not be the same. The question of which of the two principal meridians should be chosen as the meridian of reference in a given case will be taken up later in this discussion.

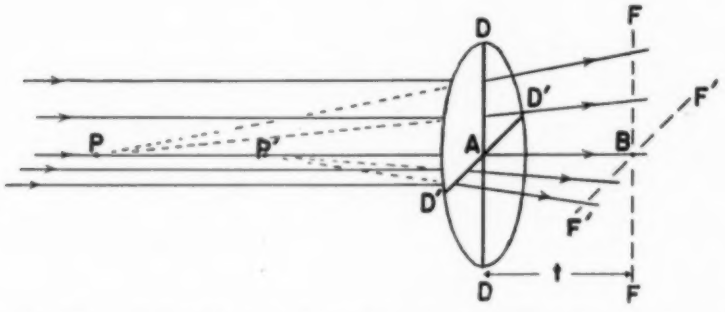

Fig. 1. The relationship of the astigmatic correction in the spectacle plane, D'AD, to the astigmatism in the plane of the cornea F'BF.

The diagram shows parallel rays refracted by the spectacle lens so that they arrive at the cornea as though from P in one principal meridian and from P' in the other principal meridian. The astigmatic error with respect to the plane of the cornea equals $\frac{1}{P'B} - \frac{1}{PB}$, or F' — F, while the astigmatic error with respect to the spectacle plane equals $\frac{1}{P'A} - \frac{1}{PA'}$ or, D' — D.

In Fig. 1 let: D = the dioptric power in the meridian of reference of the lens which "corrects the eye for parallel rays" for any given state of accommodation. That is to say that the lens power D will place the conjugate focus of the retina at infinity.

D' = the corresponding dioptric power 90° from the meridian of reference.

F = the effective power of D in the plane of the cornea.

F' = the effective power of D' in the plane of the cornea.

t = the distance from the plane of the correcting lens (the spectacle plane) to the cornea.

$$\text{Then} \quad F = \frac{1}{\frac{1}{D} - t}$$

$$\text{and} \quad F' = \frac{1}{\frac{1}{D'} - t} \qquad (1)$$

For a given eye the quantity $F-F'$ is a constant, the astigmatism in the plane of the cornea, and is represented in the equation,

$$F - F' = \frac{D' - D}{Dt - DD't^2 + D't - 1} \qquad (2)$$

If R represents the value of D when no accommodation is present and R' similarly represents D', R and R' correspond to the static refractive errors in the two principal meridians and are represented in the following equation by substitution of R for D and R' for D' in (2)

$$F - F' = \frac{R' - R}{Rt - RR't^2 + R't - 1} \qquad (3)$$

Combining (2) and (3) to eliminate the constant $(F-F')$

$$\frac{R' - R}{Rt - RR't^2 + R't - 1} = \frac{D' - D}{Dt - DD't^2 + D't - 1} \qquad (4)$$

But $(R-R')$ equals the astigmatic error of the static eye, and $(D-D')$ equals the astigmatic error of the accommodating eye, and the ratio of the astigmatic error during accommodation to that found in the static refraction equals

$$\frac{D' - D}{R' - R} = \frac{Dt - DD't^2 + D't - 1}{Rt - RR't^2 + R't - 1} \qquad (5)$$

The stimulus to accommodation, whether produced by the nearness of the object of fixation or by the addition of auxiliary lenses in the spectacle plane, can be represented by a change in lens power at the spectacle plane. If the expression of the stimulus to accommodation is limited to the meridian of reference it can then be represented by the dioptric difference between a given value for R and an assumed value for D. Then, if X is used to represent the stimulus to accommodation

$X = R\text{-}D$, whence $D = R\text{-}X$ (6)

Let S = the astigmatic error of the static eye, and let A = the astigmatic error of the accommodating eye.

Then $S = R' - R$, whence $R' = R + S$, (7)

And $A = D' - D$, whence $D' = D + A = R - X + A$ (8)

Substituting (6), (7) and (8) in (5), we obtain

$$\frac{A}{S} = \frac{(R\text{-}X)t - (R\text{-}X)(R\text{-}X+A)t^2 + (R\text{-}X+A)t - 1}{Rt - R(R+S)t^2 + (R+S)t - 1} \quad (9)$$

By re-arrangement of terms the equation simplifies to

$$\frac{A}{S} = \frac{(Rt\text{-}1)^2 + (Xt+1)^2 - 2RXt^2 - 1}{(Rt\text{-}1)^2 + SXt^2} \quad (10)$$

The usual specification of an ocular refractive error is in terms of a combination of a sphere and a cylinder. The axis of the cylinder may by transposition be specified to lie in either of the two principal meridians. If the prescription for a distance lens is written so that the axis specification corresponds to the meridian of reference the value of R will correspond to the sphere specification and the value of S will correspond to the cylinder specification.

Equation (10), then provides a general expression for the relationship between A, the astigmatic error in the spectacle plane for a near fixation object; S, the astigmatic error measured in the spectacle plane for an infinitely distant fixation object; R, the distance spherical refractive error when the cylinder axis of the distance correction corresponds to the meridian of reference; X, the stimulus to accommodation; and t, the distance between the spectacle plane and the cornea.

A, S, R, and X are in dioptric units or diopters, and t is in linear units, or meters.

Table No. 1 gives the ratio of the near cylindrical correction to the distance cylindrical correction for each of several combinations of

Sph. (R)	Cyl. (S)	t = 10mm. Stim. to acc. 2	3	4	t = 15mm. Stim. to acc. 2	3	4	t = 20mm. Stim. to acc. 2	3	4
—10	—10	1.038	1.058	1.077	1.056	1.085	1.115	1.074	1.112	1.153
—10	— 5	1.038	1.057	1.076	1.055	1.083	1.111	1.071	1.107	1.144
—10	0	1.037	1.055	1.074	1.053	1.080	1.107	1.068	1.102	1.138
—10	5	1.036	1.054	1.072	1.051	1.077	1.103	1.065	1.098	1.132
—10	10	1.035	1.053	1.071	1.049	1.074	1.100	1.062	1.093	1.125
— 5	—10	1.040	1.061	1.081	1.061	1.092	1.123	1.081	1.123	1.166
— 5	— 5	1.039	1.059	1.080	1.059	1.088	1.119	1.078	1.118	1.158
— 5	0	1.038	1.058	1.078	1.057	1.085	1.115	1.074	1.112	1.151
— 5	5	1.038	1.057	1.076	1.055	1.082	1.110	1.070	1.107	1.143
— 5	10	1.037	1.055	1.074	1.052	1.079	1.106	1.067	1.101	1.136
0	—10	1.042	1.064	1.086	1.066	1.099	1.134	1.090	1.137	1.185
0	— 5	1.041	1.062	1.084	1.063	1.096	1.129	1.086	1.130	1.176
0	0	1.040	1.061	1.082	1.061	1.092	1.124	1.082	1.124	1.166
0	5	1.039	1.059	1.079	1.059	1.088	1.119	1.077	1.117	1.157
0	10	1.038	1.058	1.077	1.056	1.085	1.114	1.073	1.110	1.148
5	—10	1.045	1.068	1.091	1.072	1.108	1.146	1.102	1.155	1.210
5	— 5	1.044	1.066	1.088	1.069	1.104	1.140	1.096	1.146	1.198
5	0	1.043	1.064	1.086	1.066	1.100	1.134	1.091	1.138	1.186
5	5	1.041	1.062	1.084	1.063	1.095	1.128	1.085	1.129	1.174
5	10	1.040	1.061	1.081	1.060	1.091	1.122	1.080	1.121	1.163
10	—10	1.048	1.072	1.096	1.079	1.119	1.161	1.116	1.178	1.241
10	— 5	1.046	1.070	1.094	1.074	1.114	1.153	1.109	1.167	1.226
10	0	1.045	1.068	1.091	1.072	1.109	1.146	1.103	1.156	1.210
10	5	1.044	1.066	1.088	1.069	1.103	1.139	1.096	1.145	1.196
10	10	1.042	1.064	1.086	1.065	1.098	1.132	1.089	1.134	1.181

TABLE NO. 1

Table of factors by which the "distance" cylindrical correction must be multiplied to give the cylindrical correction for "near".

Sph. = spherical component of the distance correction when the axis of the combining cylinder lies in the meridian for which the stimulus to accommodation is specified.

Cyl. = cylindrical component of the distance correction.

t = distance from cornea to vertex of spectacle lens in mm.

Stim. to Acc. = reciprocal of the working distance for which the "near" correction is desired, measured from the spectacle plane to the point of fixation. The stimulus to accommodation is specified in diopters.

All factors for intermediate values of t, stim. to acc., sph., or cyl. may be computed by interpolation.

sphere, cylinder, stimulus to accommodation, and distance of the lens from the eye as computed from equation (10). The original cylinder multiplied by the ratio given in the table gives the cylindrical correction needed for the specified near work.

The following examples illustrate how the table may be used.

1. Problem: Distance Rx. +10.00 sph. ⊂ —5.00 cyl. axis 90°
   No reading add
   Meridian of reference 90°
   t = 15 mm.
   Fixation distance = 40 cm.

Solution: Since for 40 cm. the stimulus to accommodation is 2.5, it will be necessary to interpolate from the ratio values of 1.074 and

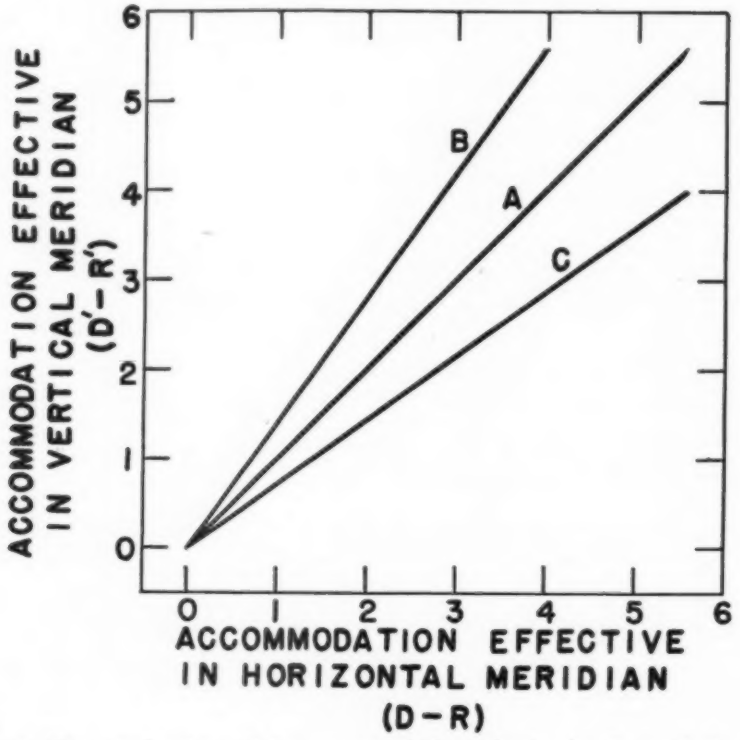

Fig. 2. The relationship of the accommodation effective in the vertical meridian (R'-D') to that effective in the horizontal meridian (R — D) for each of the three different distance corrections:

A. Plano.
B. +10.00 sph. ⊂ —10.00 cyl. axis 180°.
C. +10.00 cyl. axis 180°.

The distance from the spectacle plane lens to the cornea is taken as 15mm., and the horizontal meridian is used as the meridian of reference.

1.114 given for accommodation stimulus values of 2 and 3 diopters respectively. The interpolated value may be taken to be the mean value of the two, giving a ratio of 1.094. The cylindrical correction for near in this case equals (1.094) (—5), or —5.47 diopters. The proper near Rx should, therefore, be

+10.00 sph. ⌒ —5.47 cyl. axis 90°

2. Problem: Distance Rx. Plano sph. ⌒ —5.00 cyl. axis 75°
   No reading add
   Meridian of reference 165°
   t = 15 mm.
   Near work distance = 10″ or 25 cm.

Solution: The transposed Rx: —5.00 sph. ⌒ +5.00 cyl. axis 165°. The ratio given in the table for these conditions is 1.110. The proper near correction then becomes

—5.00 sph. ⌒ +5.55 cyl. axis 165°

3. Problem: Distance Rx. +2.50 sph. ⌒ +7.50 cyl. axis 90°
   Near add = 2.00 diopters
   t = 20 mm.
   Near work is at 8″

Solution: Transposed Rx. +10.00 sph. ⌒ —7.50 cyl. axis 180° Stimulus to accommodation = 5 — 2 = 3 diopters. The ratio obtained by averaging the table values for a —5 cyl. and a —10 cyl. (1.167 and 1.178 respectively) is 1.172. The new cylindrical correction = (1.172) (—7.50) = —8.79. The proper near correction becomes

+10.00 sph. ⌒ —8.79 cyl. axis 180° ⌒ +2.00 add

The selection of the meridian of reference is relatively simple for monocular vision. The physiological difference between the results of the two possible selections lies in the amount of accommodative effort that must be exerted. This is apparent if we consider that the variation of the astigmatism correction needed with changes in accommodation may be expressed as a lagging of the accommodation effective in one meridian behind the accommodation effective in the other as illustrated in C of Fig. 2. or, it might be expressed as an excess of the accommodation effective in the second meridian as compared to that effective in the first as is illustrated in B of Fig. 2.

If it is considered desirable that the least possible accommodation effort should be exerted when fixating an object at a given distance, the

meridian of reference should be made to correspond with the meridian of least plus power (or most minus) in the distance correction. This may be accomplished by using the plus cylinder form of the lens in applying Table I or formula (10).

If, on the other hand, there is a question of availability or ease of manufacturing or assembling of the lens it may be found more important to consider the results of using each of the principal meridians in turn as the meridian of reference.

For binocular vision other factors enter into the selection. If the distance corrections of the two eyes are essentially alike, the rules apply as in monocular vision except for the obvious provision that the criterion used in the selection of the meridian of reference must be the same for the two eyes.

If an anisometropia exists in one meridian but not in the other as, for example, in the following:

O.D. +1.00 sph. ⊂ — 5.00 cyl. axis 90°

O.S. +1.00 sph. ⊂ —10.00 cyl. axis 90°

the meridian without the anisometropia, (or with the least anisometropia) should be selected as the meridian of reference. In the above example the meridian without anisometropia is at 90°, and therefore, the Rx is already expressed in the proper sphero-cylinder form for using the formula or table.

Whenever an anisometropia exists there is always to be raised the question of whether the two eyes actually accommodate equally from a physiological point of view and, consequently, whether we are justified in correcting for the differential effect of the two spectacle lenses. That is to say that we should first remove the possibility of a physiological difference in the accommodation of the eyes which may compensate for the optical differences induced by the spectacle lenses. If, however, it is assumed that such an anomaly is not present in a given pair of eyes, special consideration must be given to the effectivity of each lens of the anisometropic correction during near fixation just as we have considered the effectivity of a single lens in each of its principal meridians.

The formula (10) which has been derived for the unequal powers in the principal meridians of an astigmatic spectacle lens has similar application, therefore, in anisometropia. In particular it is applicable in cases in which the amount of anisometropia is entirely accounted for in the differences in corneal curvatures in the two eyes.

The selection of a meridian of reference becomes most complicated, then, in binocular cases showing anisometropia in all meridians. The following may be used as an example.

O.D. +5.00 sph. ⌒ —5.00 cyl. axis 180°
O.S. —5.00 sph. ⌒ —5.00 cyl. axis 180°

In this case we have to consider any one of four possible choices, the vertical and the horizontal meridian of the right eye and the vertical and the horizontal meridian of the left. When one of these four is used the power of the distance correction in any one of the other three meridians may be expressed in terms of the amount it differs from the power in the meridian of reference. In this way the expressions may be substituted directly in the formula, R being the power in the meridian of reference, and S being the difference between R and the power in the meridian in question. By the same procedure Table I may be used directly.

To illustrate the procedure further we may tabulate the expressions for the powers in the various meridians of the example cited as follows, using, arbitrarily, the vertical or 90° meridian of the right eye as the meridian of reference.

Eye	Meridian	R	S	A/S	A
O.D.	90°	0.00	0.00	1.000	0.00
O.D.	180°	0.00	+ 5.00	1.088	+ 5.44
O.S.	90°	0.00	—10.00	1.099	—10.99
O.S.	180°	0.00	— 5.00	1.096	— 5.48

The ratio value A/S for each meridian is obtained directly from Table I assuming t = 15 mm. and the stimulus to accommodation = 3. The A value is obtained by multiplying S by A/S. Since R equals zero, the A values give the total corrected power in each meridian, and may be easily incorporated into a prescription as follows:

O.D. plano ⌒ +5.44 cyl. axis 90°
O.S. —10.99 sph. ⌒ +5.51 cyl. axis 90°

or, transposed,

O.D. +5.44 sph. ⌒ —5.44 cyl. axis 180°
O.S. —5.48 sph. ⌒ —5.51 cyl. axis 180°

This prescription represents a pair of lenses which will correct for the astigmatism and the anisometropia during the fixation of an object 33 cm. from the spectacle plane.

A point that should be made in connection with the general problem of the effectivity of the distance correction lens is that the whole

problem is eliminated when the stimulus to accommodation is reduced to zero as in the case of a bifocal add for complete presbyopia. In the instances in which a reading add eliminates only part of the accommodation stimulus, as, for example when a 1.00 diopter add is prescribed for work at 33 cm., care must be taken to compute the stimulus to accommodation correctly, which in this example would be 2.00 diopters.

The same problem of effectivity must also be taken into account in testing for astigmatism with a fogging technique as is employed, for example, with a fan dial. The addition of a plus sphere of one diopter for purposes of fogging may easily produce an error of .25 or .37 diopter in the astigmatism measurement if the distance astigmatism is in the neighborhood of 5 or 10 diopters. The precaution to be taken is simply that of reducing the fog to the very minimum in making a final decision of the amount of astigmatism present at distance.

The same consideration need not be given, however, to the possibility of an induced error in the static skiametry test as long as the astigmatic reflex is eliminated at the point of neutrality. This is true because the working-distance lens used in the skiascope test virtually places the peephole of a skiascope at infinity, for which distance the measurement is intended.

A final point of interest is the comparison that may be made between the artificially induced phenomenon with which this paper is concerned and the frequently discussed phenomenon of astigmatic accommodation. In Fig. 2 the relationship between the apparent accommodation in the vertical meridian to that in the horizontal meridian as represented by C corresponds to a deficiency or lagging of the accommodation in the vertical meridian. Stated another way, the effective accommodation in the vertical meridian is only about three-fourths that in the horizontal. This is certainly the relationship one might expect to find in a case of astigmatic accommodation dependent upon, say, the unequal contraction of the ciliary muscle. It was, as a matter of fact, the author's recent experience to measure skiascopically the changes in refraction in the two principal meridians of a pair of eyes with changes in accommodation and to interpret the result erroneously at first as dependent upon astigmatic accommodation. The subsequent computations based on the distance astigmatism clearly showed the results to be dependent upon the optical effectivity of the astigmatic correcting lens.

An incidental observation that may be made is that the astigmatism effective at near is always greater than that effective at distance. This means

that the astigmatic correction that is ordinarily referred to as a full correction, because it is the maximum indicated in the refractive examination, is in another sense a minimum or under correction. Among the clinical factors which are considered in determining whether or not a full astigmatic correction should be prescribed, this may be considered as one which would in every instance point to at least a full correction, if not an over correction, to more adequately compensate for the astigmatism during near work.

SUMMARY

The relationship between the astigmatism correction for distance vision and the astigmatism correction for near vision is expressed in a formula which takes into account the distance of the correcting lens from the eye, the distance of the fixation object, and the powers of the distance correcting lens in the principal meridians. A table is provided which facilitates easy computation of the astigmatic correction needed for near vision.

The same formula and table are applicable for the correction of anisometropia for near vision.

The applications of the formula in subjective and skiascopic testing techniques and in prescribing reading adds are discussed. The similarity of astigmatic lens effectivity to astigmatic accommodation is pointed out.

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DISCUSSION

DR. ROBERT E. BANNON, DARTMOUTH EYE INSTITUTE, HANOVER, NEW HAMPSHIRE: Astigmatic Accommodation, supposedly by sectional or meridional changes in the crystalline lens, has been a controversial subject for many years, dating from the time of Dobrowski (1868). Duke-Elder[1] writes:

> "There is no scientific foundation for such a claim . . . All the evidence goes to show that if any part of the ciliary muscle contracts in life, it contracts equally all round."

However, there is recent evidence[2] by Morgan, Mohney and Olmstead of the University of California that meridional lenticular accommodation does occur. They investigated the nervous control of the accommodation in certain animals and found in about 85% of their subjects upon stimulation of the cervical sympathetic nerve, an "accommodative astigmatism" which averaged slightly over one diopter with-the-rule. If we can assume that these observations on animals are applicable to human beings, we have another factor to consider in prescribing astigmatic corrections.

Wendell Hughes[3] and Major Saul Sugar[4] have written recently about their findings of differences in the amount of axis of astigmatism at the near point as compared to distance. Hughes discussed eight cases in which a difference between the near and far point astigmatism was found. In practically all of Hughes' cases the change from distance to near findings are not in the amount of the cylinder but in the axes. Hughes concluded:

> "It is my impression that this phenomenon may be due to a weakness in one portion of the suspensory fibers of the lens causing unequal effects on different meridians of the lens on accommodation, with irregular changes in the shape of the lens."

This assumption is particularly plausible in one of his cases in which a rupture of some of the fibers of the ciliary zonule was seen clinically but it is difficult to reconcile his contention with respect to the other seven cases.

Sugar studied a series of seventy cases in which the axes of the astigmatism was determined monocularly during and after cycloplegia for twenty feet and binocularly at both twenty feet and ten inches. Thirty-three of the seventy cases had some changes in axis. Twenty-four varied in monocular axis during and after cycloplegia; four showed changes between monocular and binocular axis at twenty feet, and fourteen eyes had changes—amounting to, at the most, five degrees—between the binocular axis at twenty feet and that at ten inches.

From Sugar's data it still is not clear that meridional accommodation could account for his results. Sugar mentioned that no cases had been reported prior to those of Hughes' in 1941. However, he overlooked a very interesting case presented by Lancaster[5] in 1916. This case may be summarized as follows:

> A young woman, aged 23, had a severe case of botulism which affected the central nervous system, especially the eyes. One of the most interesting aspects of the case was the behavior of the ciliary muscle and its effect on the refraction. Briefly stated, the astigmatism of one eye varied from +0.75 D. x 20 to +2.75 D. x 80 over a period of six months, but under cycloplegia measured only +0.25 x 90. The usual ophthalmometer findings showed +0.50 D. astigmatism but with the aid of the Souter ophthalmometer an astigmatism of over 1 D. was measured on the anterior surface of the lens. Lancaster concluded: "Moreover, it was natural to surmise that the change was due to a change in the action of the ciliary muscle. As the nuclear cells recovered from the damage by the toxin, some cells would recover better than others, and so the parts of the ciliary muscle under their control recover tone better than the other parts; from this would result an unequal tension on the suspensory ligament and a consequent unequal curvature of the anterior surface of the lens." Lancaster pointed out, however, that the conditions of his interesting case were "excessively pathologic."

Having become interested in this subject a few years ago, I have tested the astigmatic condition of several patients at both distance and near. Besides ophthalmometry and retinoscopy, the methods used were a set of astigmatic charts for both distance and near, binocular stigmatoscopy for both distance and near, cross cylinder tests on letters for both distance and near, and a polaroid (vectograph) astigmatic chart at near. I hope to prepare a more comprehensive paper[6] on this subject in the near future.

Some of the results on the patients I have examined can be explained by the change in effective power of the lenses when the fixation is at near as compared to distance. However, not all the changes—especially in axes—can be explained in this manner. Neither do I contend that sectional accommodation will explain my findings.

Dr. Hofstetter's paper is to be valued for pointing out the expected change in astigmatic corrections for near as compared to distance. I would like to indicate that it is necessary to measure patients for both distance and near if we want to determine the actual refractive condition existing in an individual patient. Mathematical analysis points the way to what we should normally expect; however, in the prescribing of a correction for a patient we should not only be guided by our knowledge of geometric optics but also by our actual findings, even though sometimes they may be contrary to what we would expect.

The recent emphasis on near point correction in industry, schools, etc., makes us realize that about the only test that we neglect for both distance and near is the measurement of astigmatism. Dr. Hofstetter has shown that astigmatic correction for distance in many instances do not fulfill the refractive needs at the near point. The considerations pointed out by Dr. Hofstetter combined with the actual measurement of astigmatic errors at the near point should enable all refractionists to investigate and prescribe more judiciously for near point work.

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POSSIBLE EFFECTS OF PUBLIC HEALTH PROGRAMS UPON OPTOMETRY*

In spite of the war and the economic condition brought about because of war-time spending, we are seemingly drawing nearer and nearer an era in which much health work will be done under governmental supervision. Just what form of socialized health care will be first inaugurated on a national scale no one can yet tell. But every indication points

*An abridgment of the material presented by Carel C. Koch, O.D., F.A.A.O., before the American Academy of Optometry at Chicago, Illinois, December 11, 1944. For publication in the March, 1945, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

toward some federal program which will include most, if not all, employees in the medium and low wage brackets. In fact, it may possibly include all persons.

The Wagner-Murray-Dingell bill is, in the writer's judgment, symptomatic of what is to come. While this particular bill in its present form will not pass both houses, it can be taken for granted that it is the forerunner of some sort of health legislation which will be enacted and which will have a far-reaching effect upon the lives of all persons residing in the United States.

The writer believes that the foregoing is a reasonably sound forecast. He also believes that the national health program as created in the future, will revolve around and be closely tied in with our present social security system.

These assumptions normally lead one to inquire as to the future of professional people whose work may be more or less regulated by the specific terms of the program already referred to and under which they will have to perform their respective services. Physicians, and eventually dentists, optometrists and nurses will find that under this national health program a large portion of their patients will come for service through the program itself.

If this is true and assuming that the terms of the legislation "bracket in" most of our population, what sort of treatment may we expect as optometrists? Also, as we perform our portion of the refractive work allotted to us as optometrists, what will be some of our experiences with the program? In other words, in dealing with the government officials who will administer the program, will we receive proper and fair treatment, or will we be "over-ridden in a rough shod manner?" And too, will such a program result in more, or less refractive work being done? And last, how will such a program affect our net annual incomes?

Before attempting to answer these four questions let me say first, that I sincerely believe that when the program includes refractions, that optometrists will be expected to enroll and carry their fair share of the eye examining necessary to the successful operation of the program. I believe this for several reasons. First, optometrists as a group are the best trained and equipped refractionists in the United States. Second, as a group they are spread over the various counties of their respective states more evenly than are ophthalmologists or oculists. Third, that optometrists being the recognized refractionists under all state laws that no act of Congress would ever attempt to usurp or upset this status. Fourth,

that under all probability some local or state participation will be required, thus placing much of the detailed administration at the local or state level. This local level has always been generally favorable to optometry. Last, because numerically optometrists are necessary to a national program including refractions if the program is to succeed.

Now what sort of treatment may we expect as optometrists? Generally speaking I believe our treatment at the hands of governmental officials will be excellent. Administrative officers and department executives must be fair and must live up to the spirit of the law as well as the letter of the law if they are to continue to hold their jobs. They know this and because most of these officials sincerely believe in the work they are doing and are in large part enthusiastic about their programs, they generally give the public and those with whom they work very fair treatment indeed. The writer has had several years of intimate experience dealing with federal civil service employees, agency heads, regional officials, district and area executives and administrative officers, and from this background of experiences with both the permanent agencies and the war agencies, I say to optometrists that they have nothing to fear on this count.

If a national health program is brought into existence including refractions, will optometrists be relegated to the position of government clerks or underlings, and will we as professional people be "over-ridden" and subjugated?

Here again the writer believes we have nothing to fear. Under any health program proposed for the United States the professional people who will perform the technical work will be treated as professional men. Their judgment will be sought and their advice followed in their own scientific and technical spheres of activity.

I also believe that they will have the fullest freedom of action, within of course, the scope of the program itself. Here again the writer draws upon his experiences during the current war period in which he has had the opportunity of observing accountants, appraisers and lawyers work in and with federal programs without losing either their identity or their professional stature.

Will such a health program result in more, or less refractive work being done?

Obviously the answer here is more. Today, even during a period of great prosperity, about one-third of our people have "take-home" incomes too low to permit them to use our services at all, while another

twenty per cent of our population can do so only at very rare intervals. This huge backlog of potential refractions is yet to be properly "tapped," and we all know that most of our regular patients visit us about once in every four years. The reason is, in most cases, that the fees we must receive to continue to practice seem high to our patients and therefore they postpone their visits to our offices as long as possible.

A federal health program would correct this situation and would open to our care a flood of new patients who both need our services and who would benefit by regular periodic visits to an optometrist.

How will such a program affect our net annual incomes?

This, of course, is anybody's guess. The writer after considerable thought believes that we as a group will not suffer financially if the program is brought into existence. In the first place, under the program the urban optometrist would be relieved of the duty of dispensing and servicing the materials he prescribes. This would, to be sure, deprive him of the profits he now makes when he dispenses these materials, but it would also eliminate the need for carrying a slow moving inventory of supplies, and the investment he now has in these materials.

It would also eliminate the cost of maintaining a laboratory in his office, which could be therefore reduced in size thus effecting a reduction in rent. It would also eliminate the present annual loss incurred in spoilage and obsolescence, and what is even more important, it would eliminate the present annual credit loss on materials which runs well into four figures in many offices.

The optometrist in the smaller rural centers would still be called upon to dispense the material he prescribes. However, this would no doubt be furnished to him in its completed form through centrally established laboratories on contract with the program itself, thus materially reducing the cost of the materials either to the program or to the patient, depending upon who is to pay for these.

As for the refraction fee allowed by the program, we may also find this reduced. In fact the writer believes he is safe in assuming that the fee paid the optometrist will be some figure between $3.00 and $5.00 for a complete ocular examination and a prescription for glasses if needed.

It is obvious, therefore, that the major source of income for the optometrist under such a program would be his refraction fees alone. On first thought it might well be assumed that his income would be very materially reduced. Actually, however, patients would call more often and many more patients would call. The optometrist who now

refracts fifteen patients each week would refract eight each day. The time now spent dispensing materials and waiting for patients would be utilized refracting, which after all is the real job of the optometrist.

While the change-over from one type of practice to another would seem strange to many optometrists, the writer believes that after the program gets under way that in general optometrists' net income would equal if not surpass the present annual income, despite the fact that he actually "banked" fewer dollars each day.

Under such a system the only monthly bills an optometrist would be called upon to pay would be his rent, salary to his secretary, telephone, incidentals and light. The balance would be his net income before taxes. With the immense backlog of refractions before us, the writer believes that every optometrist, ophthalmologist and oculist in the United States will be busier than he ever believed possible.

The writer is not recommending a program of national health care. In actual fact he believes the program will come whether he recommends it or not. These comments are presented because the subject is timely and because it will, without question, affect all optometrists. I am not concerned as to whether or not optometry is to be included in the program. I am sure it will be included when the program which is still to be adopted progresses sufficiently to include ocular refractions within its scope. I believe refractions and dental work will be included at about the same time. When this happens the technique of practice in optometry will undergo some rather drastic changes, which the writer has briefly touched upon. To prevent these changes from becoming too upsetting to our practitioners the writer believes that all possible factors should be thoroughly reviewed to enable optometrists to make the needed adjustments in their practices with the minimum of worry or inconvenience.

When these changes will take place one naturally does not know, but the fact seems inescapable that the trend towards these reforms is too strong to check. In my judgment it is therefore our duty to prepare ourselves to meet the new challenges to come, to gear our professional lives to meet the augmented refractive needs of a great host of patients heretofore denied our services and to re-dedicate our profession to the service of all of our peoples.

CAREL C. KOCH.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

ACADEMY COMMITTEE APPOINTMENTS

INTER-PROFESSIONAL COMMITTEE

Dr. J. Fred Andreae, President of the American Academy of Optometry, has appointed the following members of the Academy to the Inter-Professional Committee to serve for the year 1945. Dr. Louis W. Palm, Chairman, Dr. J. C. Russell, Dr. Arthur E. Hoare and Dr. R. M. Hall.

COMMITTEE ON RESEARCH PROJECTS

Dr. J. Fred Andreae, President of the American Academy of Optometry, has appointed the following members of the Academy to the Committee on Research Projects to serve for the year 1945. Dr. Robert E. Bannon, Chairman, Dr. Glenn Fry, Dr. Julius Neumueller, Dr. R. M. Hall and Dr. Richard Feinberg.

LOS ANGELES CHAPTER

The regular business meeting was called to order at 5:45 P. M. by the Chairman, Dr. E. A. Hutchinson. The minutes of the January meeting were read. Attention was called to the omission of recording the presentation of recommendation of Olive Salter. This is corrected and added to the January minutes. Minutes were then approved.

A letter from Dr. Arthur P. Wheelock was read. By motion passed, Dr. Harry Fuog was selected as the member our Chapter would be happy to have represent us on the Advisory Board.

Chairman Hutchinson appointed Dr. William Kinney to the Membership Committee and admonished the committee to be diligent in their duties. Dr. Kinney accepted.

A motion was made by Dr. Morrissey that each member of the Chapter be assessed $5.00, payable during the year. Motion carried. Also the recommendation that we invite Robert Downs to apply for membership was passed.

Members present were Hutchinson, Dean, Winslow, Morrissey, Kinney, McBurney, Percival, Deacon, Hoare and Wright. Visitors were: Salter, Scown, (Dr.) Sgt. (t) and Mrs. Dean Hansen, Dr. Robert Graham, Mr. Burgess, Dr. Harry A. Jankiewiez, A.M., Ph.D., and Dr. Alfons Wray.

The meeting then adjourned for dinner. After dinner Sgt. (t) Hansen made an interesting talk regarding the poison-carrying mosquitoes and the methods of testing them.

Dr. Jankiewietz then gave his lecture on "Animal Parasites Affecting the Eyes." This was illustrated with slides and very informative.

JOHN R. DEAN

PROCEDURE AND INSTRUMENTATION

Rudolph H. Ehrenberg

A department wherein discussions will be carried on relative to the value of various experimental and clinical techniques as employed by practicing optometrists, and also in which the instruments used by optometrists in various phases of their work, will be subjected to some critical evaluation.

CLINIC OF CHILD DEVELOPMENT

Yale University announced recently the grant of a sum by the American Optical Company in support of the research program of the Clinic of Child Development, which includes investigations of the growth of vision and the behavior of the eyes in infants and young children.

Commenting on these studies of ocular behavior, Dr. Arnold Gesell, Director of the Clinic, said: "Our research staff has already demonstrated that the development of vision is a long and complex process which is significantly affected by the age and maturity of the child.

"These developmental factors will be further explored in relation to the early diagnosis of visual defects, methods of treatment, and the preventive control of reading disabilities. We are also interested in the interdependence of ocular behavior patterns and personality trends."

Dr. Gesell initiated a systematic program of research soon after the Clinic was founded in 1911 and he considers the newer studies of vision in the growing child to be an organic part of that long-term program.

Research in the Clinic is conducted by a co-operative group of pediatricians, psychologists and guidance workers in the diagnostic and advisory services of the Clinic.

The Yale Clinic of Child Development is well known throughout the country for pioneer work in its special field, as reported in numerous publications, including "An Atlas of Infant Behavior" in two volumes, illustrated by 3,200 action photographs. These photographs were drawn from the unique motion picture records deposited in the Clinic's photographic research library.

A medical volume on "Developmental Diagnosis," designed for the early detection of defects and deviations in infant development, is in wide use. The volume is based on the Clinic's work and describes clinical methods of behavior examination.

The Clinic's most recent publication of a popular nature, entitled "Infant and Child in the Culture of Today," deals with every-day problems of child care and parental guidance in terms of the science of child development.

THE KEYSTONE OVERHEAD PROJECTOR

The Keystone Overhead Projector, a new development in classroom projectors, possesses several features of particular interest to teachers, according to the manufacturer, Keystone View Company. Its short-focus lenses produce a 4'x4' projection at 7 feet. Larger or smaller projections are produced by slightly moving the lantern forward and backward. The instructor faces his class at all times. The transparencies lie flat, right-side-up, in plain view of the instructor. A pencil used to point out a certain part of the content of the slide will be projected as a clear shadow on the screen, making it unnecessary for the instructor to approach the screen or even to turn toward it. Transparencies of any size from 3"x4" to 2"x2" are projected with equal ease and clarity. Shadow projection of small machine parts is quite practical with the Keystone Overhead Projector.

A most unique and practical feature of projection in the form of a special etched glass upon which pencil drawings and tracings can be made very quickly and accurately, is provided by the makers. Transparent colored crayons and colored inks and a special device for the projection of typewritten matter are supplied.

CORRESPONDENCE

VIEWS OF A U. S. ARMY OPTOMETRIST

To the Editor:

Enclosed please find a money order for a renewed subscription of the "Archives". I very neglectfully let my old subscription expire when I entered the service, and have been meaning to renew it for a long while, but like a lot of other things, put it off from time to time. Your Journal is the best professional periodical Optometry has today and I hope that you will keep up your fight for a clean Optometry and the advancement of her knowledge and research.

Reading the reports on the last Academy meeting, I am pleased to find that at last the importance of professionalism will be brought to the undergraduate via your organization. Student membership in the Academy is needed for the obvious benefits to the student and I hope that the program will be carried out with vigor.

At the same time, I am a little disappointed to note that no consideration for the Service Optometrist has been given, so that he may gain a membership to the Academy on the basis of the work he is doing in the Army or Navy, or papers that he may write while in the service. It is obvious that it would be hard to present a paper in person, for most of us in the service. The Pfc's and other "ranking" optometrists in the Army could use some stimulation, and I know that membership in the Academy would provide the incentive to write other than gripe letters to the Journals. Needless to say those "gripe letters" have just foundation and without them a bill for the commissioning of Optometrists in the Army wouldn't have been introduced into Congress. We have the clinical material to write about, and so far as I know the government has no objection to it, with certain common sense limitations.

I graduated from Northern Illinois College of Optometry in May, 1942, completing the usual four year course. My first six months of practice was in association with Dr. Eugene Freeman, a member of the Academy, and a professor at the college. Following this I began my own practice sharing a suite of offices with two physicians and a dentist in the Hyde Park Bank Bldg., Chicago, Ill. I entered the Army in May of 1943, classified a 452 (optometrist) and except for a brief period as an assistant in oral surgery, I have been refracting here at the Station Hospital. I have been very fortunate in having fine ophthalmologists to work with and have gained a first hand knowledge of clinical

ophthalmology and ocular surgery as well as refracting every conceivable type of case over and over again. We G.I. optometrists have gained infinitely in experience, and although the slaps in the face have been plenty, we are not the first optometrists that have been slapped.

A great many of our professional brothers are going to be surprised to see that the fight we have is among ourselves and the G.I. optometrist has a score to settle with groups and types of practitioners and even associations. We know that there is nothing wrong with Optometry except some of the men in it. We will need a strong and closely knit organization after this war. The Academy already has the ways and means to keep out the undesirables. There is strength in unity, but one can't unite good and bad. The day has arrived when a break, clear and clean, must be made between those of us desiring complete professional recognition with willingness to practice without the slightest taints of being merchants in the eye ware, and those that must have a store front, or small neon signs or any other half hearted concessions to their fears of customer loss. The "Venetian Blind Merchant" in Optometry today is not a step in the right direction, but a rationalization of professional manners, and it hurts to see how some of our associations are putting the stamp of approval on a group that will be harder to root out than the bait advertisers. Professional offices on the ground floor are fine as long as they remain offices in the professional sense of the word, but some that I have seen look more like the outside of a beauty parlor. Medicine and Dentistry have set the standards of good manners for a Doctor to follow, and they will not accept us with dirty shirt fronts.

For the first time in the history of our young profession, a large group of us have been working hand in hand with the ophthalmologists. We have learned their views on optometry and her problems. We have seen their respect for our ability, and have gained admiration and praise in all the fields of eye work in which we are skilled. Make no mistake about it, the ophthalmologist is the truest friend Optometry has in the Medical professions and not our enemy as we have been led to believe. However, he is not going to step into our associations and tell us that we must do this or that. He is not going to be so rude; we must clean up our own house. There is not the slightest argument as to how to refract, how to take phorias, how to prescribe the correcting lens, etc. The physiology, pathology and psychology of seeing taught in their schools is the same as is taught in ours. I recently went over a course

of study in Ophthalmology, and the notes read like my own lectures received at Northern Illinois.

Even the big "boogy-man" of Cycloplegic refraction has proven to be a much misunderstood issue with both the ophthalmologist and optometrist. Any good refractionist that uses a cycloplegic for diagnostic reasons or to overcome ciliary spasm knows that a post-cycloplegic must be done before prescribing or he is going to have a fogged patient back in his office complaining. He also knows that the correct procedure is to first refract the patient without homatropine and use only if indicated. I could cite a number of cases in which cycloplegic was a valuable aid in refraction, however there are ways to get the same results without it. There is no argument here, and I only wish that the optometrists could learn this and quit making an issue of it.

We are looking forward to your leadership and I hope the Academy will not let us down.

PFC. LEONARD M. GLICKSTEIN

E.E.N.T. CLINIC
STATION HOSPITAL
CAMP MC COY, WISCONSIN

ANNOUNCEMENTS

INDIANA SEMINAR AT PURDUE

A seminar on Industrial Vision was held February 24th and 25th at Purdue University for members of the Indiana Association of Optometrists. It was attended by an appreciative group of forty-one optometrists.

Purdue University, through its Department of Industrial Psychology has pioneered in the solution of many of the problems of Industrial Vision and the men in that department are recognized authorities in the field.

Dr. Joseph Tiffin opened the seminar with a discussion on the background and development of research in industrial vision. He pointed out that, early in the development of solutions for some of the problems of industry, visual problems were at the root of many of the troubles that bothered production men. He discussed the relationships that were soon uncovered between visual problems and production difficulties.

Dr. S. E. Wirt, who assists Dr. Tiffin in the Department of Industrial Psychology, pointed out that it was learned early in their research that the then known tests for visual troubles were inadequate for use in industry. The task they set themselves was to devise tests that were practical for industry, which gave them the information that was required and which were able to stand up under statistical scrutiny. From this work, there evolved the battery of tests that have been incorporated into the Ortho-Rater.

Dr. Wirt carefully presented the reasons for the adoption of the various tests and gave ample reasons for discarding some that are more familiar. In particular, the tests for visual acuity came in for discussion and evaluation. All the men present were exceedingly interested in the clinical application of this type of test. They all agreed that the Navy's adoption of it would be the forerunner of wider usage of it.

The application of the information gained by a valid method of testing the eyes of employees was carefully covered by Drs. Tiffin and Wirt. Occupational eyewear and other methods in which the professional man can help industry meet its problems came in for the greater part of the discussion.

Mr. H. P. Brownell of the Personnel Department of the International Business Machines Corp. discussed the results of their visual program, as it affected the efficiency of the workmen. He stated that, as a result of their testing program, about ten per cent of their employees were directed to seek the assistance of professional eye care. He stated that, since "near vision is the vision for industry," they had come to learn the peculiar type of service that optometrists have to offer and had received excellent cooperation from all of the optometrists in their community. He stressed the fact that optometrists must cooperate closely with industry to make the program effective.

On Sunday evening, the optometrists and their wives met at the Lafayette Country club as guests of the university. Dr. E. C. Elliott, president of Purdue and Dr. F. B. Knight, Director of the Division of Education and Applied Psychology, greeted the optometrists, commended them for their interest and stressed the importance of the service they were rendering. Dr. E. J. Cain, president of the Indiana Association of Optometrists, replied with appropriate remarks, thanking the University and its staff for the many courtesies that were extended.

Those optometrists who attended the seminar were enthusiastic in their praise for the material that was presented, the facilities that were

placed at their disposal and for the manner in which their questions were answered. There was a universal comment that it was unfortunate that every optometrist could not have attended the seminar. They were unanimous in their desire for another such a meeting in the not too distant future.

REPORT OF THE FIRST INDIANA CONFERENCE ON INDUSTRIAL VISION

The 35 page, paper bound report of the First Indiana Conference on Industrial Vision is an important contribution to the literature on industrial optometry.

The report contains: A Foreword by Dr. Emerson J. Soland, Chairman and Coordinator of Industrial Vision of the Indiana Association of Optometrists; an address by the Hon. Henry F. Schricker, Governor of Indiana; "Safety Is A Cinch," by Major John F. Jones, chief of the inspection section Security and Intelligence Division at Headquarters, Fifth Service Command; "Eye Protection In Industry," by Mr. G. A. Kuechenmeister, personnel and safety manager of the Dominion Forge and Stamping Company of Walkerville, Ontario, Canada; "Vision and Eye Protection in Industry," by William T. Cameron, formerly chief safety adviser of the Division Labor Standards, U. S. Department of Labor, Washington, D. C.; "The Professional Man's Viewpoint," by Dr. Richard Feinberg, eye service supervisor in the medical department of the Sperry Gyroscope Company; "Report of the Committee on Industrial Vision" of the A.O.A. presented to the 47th Annual meeting of the House of Delegates, Detroit, Michigan, June, 1944; and the Open Forum discussion. The Public Health Bureau of the American Optometric Association recommends that optometrists interested in industrial vision problems secure a copy of this report. This publication may be secured from the Department of Public and Professional Relations, Indiana Association of Optometrists, 605 State Life Building, Indianapolis 4, Indiana. The price is 50 cents.

ABSTRACTS

A department in which will appear abstracts of the literature of optometry, ophthalmology and applied optics. These will be classified according to the following list although contributions to all sections will not necessarily appear in each issue.

1. Ocular Refraction.
2. Physiological Optics and Color Vision.
3. Ocular Muscles.
4. Orthoptics and Reading.
5. Anatomy, Histology and Embryology.
6. Ocular and General Pathology.
7. Ophthalmic Lenses and Material.
8. Instruments.
9. Hygiene and Illumination.
10. Applied and Physical Optics.
11. Education, Sociology and Economics.
12. Miscellaneous.

2. PHYSIOLOGICAL OPTICS AND COLOR VISION

GEOMETRIC FORMULATION OF CLASSICAL COLOR HARMONY. P. Moon. Journal of the Optical Society of America. 1944, 34, 1, 46-59.

The author presents a scientific development of the classical theories of color harmony. The qualitative ideas of artists and color specialists have been incorporated into a quantitative system depending on the C.I.E. color specification and its transformation into a metric color-space. The entire theory is based on two postulates: pleasing intervals and ambiguous intervals exist between colors, and an orderly geometric arrangement of colorprints leads to harmony. On this foundation is built a classification of harmonies and these harmonies are tabulated in some detail. The combinations are by no means equally pleasing, but elements of order can be discerned in all of them.

The division into regions of similarity, ambiguity, contrast, and glare is in accordance with classical color harmony. But the numerical designations of these regions are new and are based on preliminary experiments. Similarly, geometric paths through the color solid have been employed by many artists and art teachers—notably by Munsell, Ostwald, Birren, and Graves—but the previous work has lacked definiteness and has not been related to the C.I.E. system of color specification. The numerical limits presented in this paper were determined with a small number of observers and are to be considered as tentative values which could probably be improved by a more extensive research.

The advantage of the method is that it gives the designer a wealth of new harmonies from which he can select the particular one best fitted to his needs. As with any other scientific aid to the artist, a theory of color harmony can never replace artistic genius, and it makes no such claim. It is merely a tool by which the artist can obtain the desired effect more directly. Classical color harmony is confined to relations among

colors, irrespective of area. In this paper Moon has simplified conditions to agree with classical theory. Areas are always kept equal, adaptation is fixed at a neutral gray of Munsell value 5, and no attempt is made to compare the various harmonies aesthetically.

A. V. F.

SUBNORMAL VISION AND OCCUPATIONAL APTITUDE. A. C. Snell, New York State Journal of Medicine, 1941, 41, 1165.

Snell believes there should be established by some authoritative medical organization, in cooperation with safety engineers, labor, and management, visual aptitude standards for specific positions or jobs. These standards should be the minimum consistent with the nature of the employment but should be sufficiently high to assure efficiency in production and safety to employees. The establishment of such visual aptitude standards will place many qualified employees in suitable and productive positions that are denied to them at the present time. The point he makes is, that all jobs do not require normal vision.

A. V. F.

CAUSES OF READING RETARDATION. S. S. Center. Optometric Weekly, 1944, 35, 17, 457-458.

At the Reading Clinic of the New York University the following techniques are employed to overcome the problems of the slow reader. The patient is first given an intelligence test. Next a screening test is made with the telebinocular. Then, if necessary the patient is refracted. Following this, the ophthalmograph is used to make at least two reading graphs showing the patient's speed of reading and visual behavior while reading. Next tests are made of the patient's spelling, vocabulary and reading ability. Following this study of the case, the patient then receives remedial reading treatments to correct the defects which are found present.

C.C.K.

PROTECT YOUNG EYES. H. W. Lane. Hygeia. April, 1944.

Parents are warned of the insidious onset of amblyopia. This occurs when, the eyes not focussing naturally together, the child finally gives up the effort of forcing them to look at a single object, and simply sees with one eye until the other weakens from disuse. Tendency toward

amblyopia is hereditary, says Lane, but its development can be avoided by watchfulness and treatment during the pre-school years. Lack of vigilance and carelessness about securing treatment will throughout life limit the amblyope's recreation and choice of vocation.

A.V.F.

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4. ORTHOPTICS AND READING

VISUAL TRAINING: PROFESSIONAL SERVICE. C. A. Kauffman. Optometric Weekly. 1944, 34, 48, 1378.

In prescribing orthoptic training the author suggests several rules which he has found helpful. These are, (1) Consideration should be made as to the distance from your office that the patient will have to travel in order to obtain visual training. (2) Explain to the patient that you have the equipment, but that the results obtained from the use of the equipment depend on him and upon how hard he will work in order to obtain good results. Place the weight of the burden of the responsibility on the patient to begin with, in order to obtain successful results. (3) Explain to the patient that discomfort may result in the beginning of the training period, also, that the achievement level may be lowered temporarily at that time but will return later on towards the end of the visual training. Keep motivation of the patient at a peak throughout. (4) Set up a visual environment for the patient and explain to him what he is going to do for himself during the training, because results will depend on his own interest in the work. (5) Let the patient adjust his own instruments. (6) Let the patient make his own adaption, such as changing the cards in the instruments, etc. (7) Let the patient score his record, as this will enable him to take more interest and to achieve to a higher level. The patient will get the idea, which is desirable, that he is doing the job. (8) If the patient is not doing a good job, make him get down to work. In other words, let him know he is not taking enough interest in order to obtain results.

A. V. F.

THE ORTHOPTIC TREATMENT OF AMBLYOPIA. S. E. Rudlin. Mid-West Optometric Journal. 1943, 10, 11, 14-15.

In treating amblyopia ex anopsia the author suggests the combined use of the "flash" technique and the Keystone tel-eye-trainer and the most effective means of stimulating visual centers.

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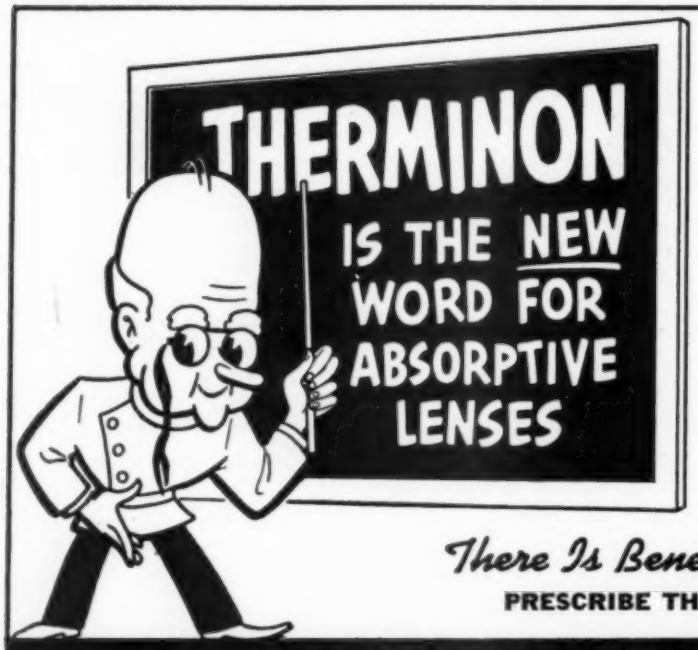

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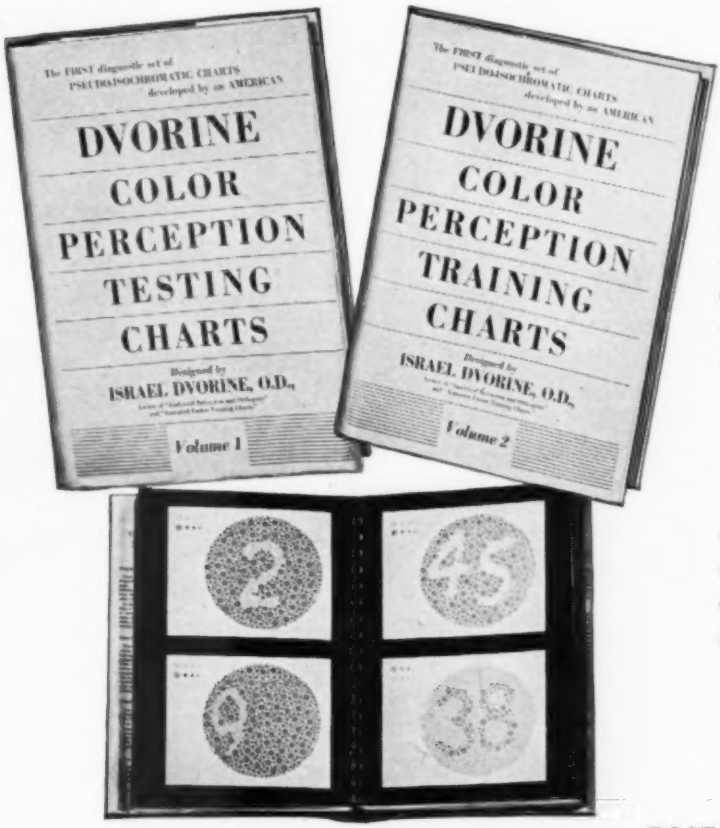

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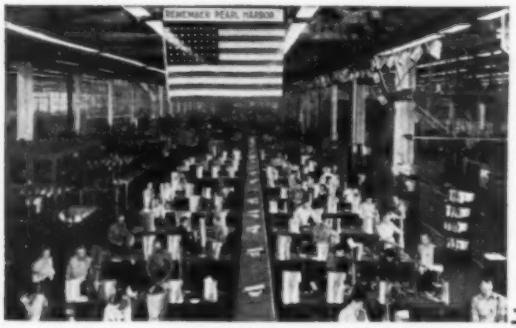

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